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Agriculture & Forestry GHG Reduction Opportunities

Key to Indicators: These are rough estimates based on experience or studies in AZ or elsewhere and are intended to start off discussion. Actual AZ-based estimates will be developed for options that stakeholders decide to pursue in more detail, and may differ significantly from the preliminary indicators provided here.

Indicative Potential Emission Reductions* -	**Indicative cost ($/tCO2e)**
High (H): Potentially capable of saving at least 1 Million Metric Tons CO2e per year by 2020 (~1% of current AZ emissions)	**High (H)**: $50/tCO2e or above
Medium (M): Potentially capable of saving from 0.1 to 1 Million Metric Tons per year by 2020	**Medium (M):** $5-50/tCO2e
Low (L): Unlikely to yield more than 0.1 Million Metric Tons CO2e per year by 2020	**Low (L):** $5/tCO2e or lower
Uncertain (U): Too many unknowns to estimate	**Negative (Neg):** Cost Savings

** Several measures overlap in terms of the emissions they would reduce. They may target the same emissions sources, but using different implementation pathways. The estimates shown here assume that measures would be implemented independently from, or instead of, other measures.*

Indication of Priorities:

- **High:** High priority items are deemed deserving of considerable further analysis.
- **Medium:** Medium priority items will be carried forward, with the extent of further consideration and analysis to be determined later.
- **Low**: Low priority items will be moved to a separate list as options to be potentially considered at a later time.

		Priority: High, Med, Low	Implement. Level & Lead Agency	Potential Emission Reductions	Indicative Cost ($/tCO2 removed	Other Information, Co-benefits, Feasibility Consideration, Examples of Current Activities
	Agriculture – Production of Fuels and Electricity					

		Priority: High, Med, Low	Implement. Level & Lead Agency	Potential Emission Reductions	Indicative Cost ($/tCO2 removed	Other Information, Co-benefits, Feasibility Consideration, Examples of Current Activities
1.1	Manure Digesters (methane recovery and electricity production)		State, Local Ag. Ext.	Medium	Neg to Low	• Linked with Option 2.2 below
1.2	Biodiesel Production (incentives for feedstocks and production plants)		State	Medium	Med to High	• Production from both virgin and waste vegetable oils; • Seed oil production in AZ feasible (e.g. soy and rapeseed)?
1.3	Biomass Feedstocks for Electricity or Steam Production		State	Low	?	• Need to identify viable feedstocks and volumes [e.g., crop residue (wheat straw, corn stover) or energy crops (switchgrass); • Linkage to Energy Supply TWG to determine availability of biomass plants • Linkage to RCI TWG to identify available capacity for biomass generated steam
1.4	Ethanol Production		State	Medium	Med to High	• Current debate on the energy required for ethanol production
1.5	Convert Diesel Farm Equipment to LNG/CNG or Hybrid Technology		State	Low	Med to High	• LNG/CNG engines or engine conversions reduce BC emissions • Availability of diesel hybrid equipment for farm applications?
1.6	(Additional option, if/as suggested)					•
1.7	(Additional option, if/as suggested)					•
	Agriculture – Fertilizer and Manure Management					
2.1	Nutrient Management (improve efficiency of fertilizer use)		State, Local Ag. Ext.	Medium	Low	• Note Ag. Best Management Practices under ARS §49-457 (do these extend beyond dust control and water efficiency measures?) • Linked to Option 3.4 below.
2.2	Manure Management (practices to reduce methane emissions)		State, Local Ag. Ext.	Medium	?	• Linked with Option 1.1 above. • Existing waste containment requirements for animal feeding operations > or = 1,000 head. • Could include composting and other measures. • Most of the benefit achieved at dairies. • Co-benefits include reduction of ammonia and VOC emissions.

		Priority: High, Med, Low	Implement. Level & Lead Agency	Potential Emission Reductions	Indicative Cost ($/tCO2 removed	Other Information, Co-benefits, Feasibility Consideration, Examples of Current Activities
2.3	Change Feedstocks (optimize nitrogen for N_2O reduction)		State, Local Ag. Ext.	Low to Medium	Low	• Most of the benefit achieved at feedlots. • Co-benefits include reduction in ammonia emissions.
2.4	Reduce Non-Farm (Residential and Commercial) Fertilizer Use		State	?	?	• Emissions from non-farm application are not currently in the inventory; unclear what the reductions and costs would be.
2.5	(Additional option, if/as suggested)					•
2.6	(Additional option, if/as suggested)					•
	Agriculture – Soil Carbon Management					
3.1	Conservation Tillage/No-Till (carbon sequestration and reduced energy use)		State, Local Ag. Ext.	Medium	Low	• Boll Weevil eradication program requires cotton residue to be plowed under (conservation tillage not applicable to cotton)
3.2	Reduce Summer Fallow (increase soil C content, reduce N_2O emissions)		State, Local Ag. Ext.	?	?	• Applicability to AZ? • Need estimates of fallow summer acreage
3.3	Increase Winter Cover Crops (increase soil C content, increase soil N content)		State, Local Ag. Ext.	?	?	• Applicability to AZ? • Need estimates of winter acreage available for cover crops
3.4	Improve Water and Nutrient Use (to minimize soil C loss)		State, Local Ag. Ext.	Low	Low	• Linked to Option 2.1 above; Suggest combining these two.
3.5	Rotational Grazing/Improve Grazing Crops and/or Management		State, Local Ag. Ext.	Low	Low	• Applicability to AZ?
3.6	(Additional option, if/as suggested)					•
	Agriculture – Land Use Change					
4.1	Convert Land to Grassland or Forest		State	Medium	?	• Opportunities for conversion in AZ?
4.2	Reduce Permanent Conversion of Farm and Rangelands to Developed Uses		State, County, City Planning Offices	High	?	• Reductions occur both from higher retention of carbon in soil and lower transportation activity. • Linked to Option 4.3. • Linked to Smart Growth Options in the TLU TWG.
4.3	(Additional option, if/as suggested)					•
4.4	(Additional option, if/as suggested)					•
	Agriculture – Farming Practices					

		Priority: High, Med, Low	Implement. Level & Lead Agency	Potential Emission Reductions	Indicative Cost ($/tCO2 removed	Other Information, Co-benefits, Feasibility Consideration, Examples of Current Activities
5.1	Organic Farming		State, Local Ag. Ext.	Medium	Low	• Reductions occur via lower intensity agricultural practices (nutrient/pesticide application, reduced tillage)
5.2	Programs to Support Local Farming/Buy Local		State, Local Ag. Ext.	Medium	?	• Reductions occur through lower transport related emissions.
5.3	(Additional option, if/as suggested)					•
5.4	(Additional option, if/as suggested)					•
	Forestry – Biomass Protection and Management					
6.1	Forest Protection – Reduced Clearing And Conversion to Nonforest Cover		State, City/ local	**High**	**Low**	• depends on business as usual rates of land clearing and viable alternatives
6.2	Increase Maintenance of Urban and Residential Trees		State, City/ local	**Low**	**Low to high**	•
6.3	Afforestation of Nonforested Rural Lands		State, City/ local, federal	**Low to high**	**Low**	• depends on available acreage and risk
6.4	Afforestation of Nonforested Urban Lands		State, City/ local, federal	**Low to high**	**Low**	• depends on available acreage and risk
6.5	Reforestation/Restoration of Forested Lands		State, City/ local, federal	**Low to high**	**Low**	• depends on available acreage and risk
6.6	Reforestation or Increased Stocking of Stands		State, City/ local, federal	**Low to high**	**Low**	• depends on available acreage and risk
6.7	Age Extension of Managed Stands		State, City/ local, federal	**Low**	**Low to high**	• involves significant tradeoffs with carbon savings from harvested wood products, as well as ecological risk
6.8	Thinning and Density Management of Managed Stands		State, City/ local, federal	**High**	**Low to high**	• cost and technology barriers to market use of harvested biomass may be high; supply potential is high
6.9	Fertilization and Waste Recycling		State, City/ local, federal	**Low**	**Low to high**	• site and situation specific

		Priority: High, Med, Low	Implement. Level & Lead Agency	Potential Emission Reductions	Indicative Cost ($/tCO2 removed	Other Information, Co-benefits, Feasibility Consideration, Examples of Current Activities
6.10	Expand Short Rotation Woody Crops (for fiber and energy)		State, City/ local, federal	**Low to medium**	**Low to high**	• depends on available acreage and market demand
6.11	Expanded Use of Genetically Preferred Species		State, City/ local, federal	**Low**	**Low**	• primary issues in the southwest are reductions of fuel load and restoration of native species
6.12	Modified Biomass Removal Practices (reduced decay and energy use)		State, City/ local, federal	**Low**	**?**	• may be opportunities to use biofuels for equipment
6.13	Fire Management and Risk Reduction Programs		State, City/ local, federal	**High**	**Low to high**	• implementation and market barriers may be significant, potential is high if biomass is directed to constructive reuse
6.14	Forest Health Risk Reduction Programs (pest/disease, invasive species)		State, City/ local, federal	**High**	**Low to high**	• implementation and market barriers may be significant, potential is high if biomass is directed to constructive reuse
6.15	Drought Management Programs (tree selection, placement, protection)		State, City/ local, federal	**High**	**Low to high**	• implementation and market barriers may be significant, potential is high if biomass is directed to constructive reuse
6.16	Flood and Riparian Management Programs (tree selection, placement, protection)		State, City/ local, federal	**Low**	**Low to high**	• depends on available acreage
6.17	Watershed Management Programs (stand retention, enhancement and management)		State, City/ local, federal	**Low to high**	**Low to high**	• depends on available acreage and forest health issues
6.18	Habitat Management Programs (stand retention, enhancement and management)		State, City/ local, federal	**Low to high**	**Low to high**	• depends on available acreage and forest health issues
6.19	(Additional option, if/as suggested)		State, City/ local, federal			•
	Forestry - Wood Products and Waste					
7.1	Improved Mill Waste Recovery		State, City/ local, federal	**Low to high**	**Low to high**	• technology and market dependent

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7.2	Improved Logging Residue Recovery		State, City/ local, federal	**High**	**Low to high**	• technology and market dependent
7.3	Expanded Use of Small Diameter Trees for Wood Products and Energy		State, City/ local, federal	**High**	**Low to high**	• technology and market dependent
7.4	Expanded Use of Wood Products for Building Materials		State, City/ local, federal	**Medium to high**	**Low to high**	• technology and market dependent
7.5	Expanded Use of State and Locally-Grown Wood Products		State, City/ local, federal	**Low to high**	**Low to high**	• technology and market dependent
7.6	(Additional option, if/as suggested)					•
7.7	(Additional option, if/as suggested)					•
	Forestry – Energy Production					
8.1	Expanded Use of Forest Biomass Feedstocks for Electricity (fuel switching)		State, City/ local, federal	**High**	**Low**	• technology and market dependent
8.2	Improve Use and Efficiency of Wood for Direct Commercial Heat and Energy		State, City/ local, federal	**High**	**Low**	• technology and market dependent
8.3	Improved Energy Capture from Wood Waste Combustion		State, local, private	**Low to high**	**?**	• technology and market dependent
8.4	Expanded Landfill Methane Recapture (wood products waste)		State, City/ local	**Low**	**Neg to Low**	• Federal New Source Performance Standards and Emissions Guidelines require methane capture at larger landfills.
8.5	Improved Commercialization of Biomass Gasification and Combined Cycle		State, City/ local, federal	**Low to high**	**Medium to high**	• requires improved technology and market incentives
8.6	Expand Usage and or Efficiency of Wood Waste as Residential Fuel Source		State, City/ local, federal	**Low - Medium**	**Low**	• Overlap with RCI sector.
8.7	(Additional option, if/as suggested)					•